CAVE FAUNA

BY

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This short note on cave fauna will be restricted to a consideration of those forms of animal life capable of living generation after generation in parts of caves remote from any entrance and in total darkness. These will be referred to as 'troglophils'. In contrast with these we have those animals which live outside caves on the surface or below ground as far as the lowest penetration of roots of trees, or in the holes made by worms, foxes, etc.

There is an intermediate fauna of very great interest. This is the fauna which uses the thresholds or antechambers of caves. Some of them go in to hibernate—flies, moths, reptiles, etc.; others, such as swiftlets and bats, use the cave as a habitation going outside for their food. Associated with this last class is a great concourse of creatures living as parasites, or on the droppings or on the moulds growing thereon. These may be mites, myriapods, insects, molluscs, isopods, etc.; and then there are the animals that prey on them,—beetles and their larvae, spiders, etc.

In one such cave in the Simla Hills which housed a large colony of bats, there was such a multitude of large snails that they could not be avoided. Every footstep crushed five or six of them.

Some members of this threshold community are potential troglophils, but usually the effect of the occupation of part of a cave by large numbers of bats or swiftlets is to drive away all troglophils not ecologically adapted to this environment, to the unpolluted parts of the cave. Thus in Swiftlet Pot in the Chakrata Tahsil, U.P. the main part of the cave, where the swiftlets nest, contains no troglophils. These are found in this cave only in a very small deeper chamber difficult to reach. Here the true cave collembola and spiders are found in surroundings unaffected by the birds.

The study of this threshold fauna is important. It can be pursued not only in natural limestone caves, but also in any large cavities in rocks, in artificial caves such as at Elephanta, in the entrances to ancient mines and in the deeper chambers and passages of old forts. Naturalists who have not got the opportunity or the inclination to penetrate deeply into extensive caves will find this study well worthwhile.

2. Troglophils may derive from ancestors which entered the cave at different periods of its formation. Hence since deep caves are almost invariably due to the solution of limestone by water, a brief account of the origin of limestone caverns is required here.

Limestone caves are usually considered to have been formed by solution or erosion due to surface water trickling through joints and fissures. If there is an actual stream running through the cave, or near by, it is pointed out as the stream which made the cave. This is seldom the case. As J. Harlen Bretz says 'Most caves are out of adjustment with the topography of their region, and therefore are older than the present cycle of erosion.' This is emphatically the case with all caves in India seen by the writer.

According to the modern theory of cave formation there are three stages in their development. These are:

First or Phreatic Stage.

This is due to solution by water *under pressure*, that is, below the local water table. Often it will have commenced beneath a peneplain towards the close of a previous cycle of erosion. Some clay-filling may occur at this stage.

Population of the water-filled solution cavities is only possible for minute animals since these must filter through the very narrow cracks in the overlying rocks or soil.

Many minute crustaceans are less than a millimetre in greatest dimension and their entry will usually be quite possible. At the same time minute fragments of vegetable or animal matter will percolate through and provide food. In this connection it is interesting to enquire whether the water table below the Indo-Gangetic alluvium contains a subterranean population. If this is so, it may be brought to the surface in areas of tube well development. Only careful examination over a long period would disclose the existence of these tiny transparent animals.

Second stage: Removal of Phreatic Water.

Following uplift of the land introducing the present cycle of erosion, the phreatic system of cavities begins to drain out, at first in the upper parts only; later as uplift or external erosion proceeds, perhaps the whole will be drained.

In the parts of the system now drained, isolated pools containing Stage 1 fauna may remain. In the air-filled cavities stalactites and stalagmites and other calcite deposits will begin to form.

These cavities now offer a home for land troglophils. So long as there is no obvious opening, their colonization will depend on the extent to which narrow joints in the rock contain a subterranean population. Dr. Racovitza of the Speleological Institute, Cluj, has suggested that the innumerable narrow joint cracks in limestone hold a teaming population, and that the population of the larger cavities is only a small fraction of the whole.[1] This is difficult to prove or refute. There are great numbers of large subterranean cavities isolated from the surface. These may be detected by geophysical methods or penetrated by chance by mine-shafts. If on first penetration of such a cavity, immediate examination for fauna (and flora i.e. fungi) could be made, the results whether negative or positive would be useful.

It is a fact that certain cave beetles show a marked development of sensory hairs on their elytra which seem designed to protect them from becoming jammed during wanderings in narrow cracks, and others, e.g. opilionids, even in the remotest parts of caves are only to be found under stones or in crevices.

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[1] Biospeologica II, 1907 p. 386, by E. G. Racovitza (archives de zoologie expérimentale, Paris Libraviie H, Le Soudier).

The early stages of some cave beetles have never been found in spite of intense search, though the adults are common. The assumption is that this part of their lives is spent in crevices.

The absence of local races or subspecies in separate caves in the same area would be an argument in favour of migration along joint cracks.

It must be remembered too that, to a creature whose height is less than a millimetre, a fissure two or three millimetres wide is a roomy passage. Hence without any obvious surface openings a subterranean cavity may become populated by land troglophils during the Second Stage.

Third or Vadose Stage.

In this stage the water in the cavities is not confined under pressure but has a free surface.

As soon as the joints or fissures are sufficiently open to admit rain water freely to the air-filled cavities below, the third stage commences. If at any time a surface stream, eroding its banks or deepening its bed discovers a cave and pours into it, this stage proceeds at an accelerated pace.

The rainwater or the stream carrying debris and silt commences secondary erosion and solution, or clears away to lower parts the clay-fill of the first stage where this existed.

The intruding streams are misfits in the caves and alter them

Surface streams and flood water will wash in water- and land-animals; most of these will be unsuited to cave life but will provide food for the troglophils. Others will add to the cave population.

Some parts of the caves may be untouched by vadose streams; other parts may be affected for a time and then be cut off by the deeper erosion of the main stream channels. Finally the surface drainage may cut down so far below the cave that there is no further flooding in of water-forms, but the way is clear for the entry of land animals.

This brief description of the origin of limestone caves is very incomplete. Those who wish to read more about it should refer to the works of Professors William Morris Davis[1] and J. Harlen Bretz.[2]

3. I have tried to give a picture of the continuous invasion of caves from the first stage of their formation to the present time. The earlier stages may have occurred at a remote period long before the emergence of Man, and at that time the cave may have been in very different surroundings and climate.

So little collection has been done in Indian caves that there is little evidence, so far, to show to what extent animals from the earlier stages may have lingered on in caves after vanishing from the surface.

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[1] Origin of limestone caverns by W. M. Davis *Bulletin* of the Geological Society of America, Vol. XLI (1930), pp. 475-628.

[2] Vadose and phreatic features of limestone caverns by J. Harlen Bretz The *Journal of Geology* (University of Chicago Press) Vol. L, No. 6, Part II (1942), pp. 675-811.

Troglophils are usually representatives of groups not much studied, and the discovery of a new genus or species in a cave does not necessarily mean that it is not to be found on the surface.

Thus, for instance, the recent discovery of a palpigrade (*Arachnida*) in an Indian cave has no special significance, although it is believed that this is the first find of this family in India. It has a world-wide distribution and may well have surface forms in India which have not yet been recorded.

The large cave *Campodea* which the writer found in two widely separated caves in the Simla Hills is probably a survival in caves from a time when *Campodea* of this size were widely distributed as surface forms. This striking creature is much larger than the *Campodea* of the Mamouth Caves of America, which are themselves larger than any known surface forms.

A *Collembola* found in certain caves in the Dehra Dun District, U.P., is described by Dr. R. S. Bagnall as an *Onychiurus* of exceptional interest since it combines the features of two distinct groups. So this also seems to be a sort of living fossil.

4. If the long survival in caves of certain troglophils is established, the question arises—To what extent are the present survivors similar to their surface representatives at the time of their first migration into caves? or in other words—What changes have occurred during their sojourn in caves?

Before attempting to answer these questions, it is first necessary to enquire what sorts of creatures are capable of colonising the deeper parts of caves, i.e. What are the potential troglophils?

These are:

I. Land Animals.

A. Non-predators

Those dependent on green vegetation, or dependent on specific food not obtainable in caves are excluded. The food of non-predatory troglophils is decaying vegetable or animal debris, moulds and other fungi.

Large animals cannot survive for want of food sufficient to support them for long.

Hence non-predatory troglophils are derived mainly from those small creatures living on the surface in humid micro-caverns i.e. in fox holes, underground ant nests, etc., in cracks of rocks or under stones, under bark, under dead wood or leaves, or deep in wet moss, etc.

The importance of humidity must be stressed. Troglophils are characterised by an intolerance of a dry atmosphere.

Migration into caves is not deliberate but is the result of response to an urge to seek any dark damp place and in some cases narrow and confined places.

The chief non-predatory troglophils are:

(i) Primitive wingless insects of the order *Apterogota-Collembola* (Spring-tails).

(ii) Certain families of *Diptera* e.g. *Mycetophyllidae*.

(iii) *Arachnida*—Mites.

(iv) *Myriapoda—Diplopoda* (millipedes).
(v) Worms.
(vi) Molluscs (snails).

Collembola usually form the chief non-predatory part of a cave community, and provide sustenance for many of the predators.

B. Predators

These are in general those which, on the surface, live in the same situation as the non-predators which are potential troglophils, as in A above, in order to prey on them.

Also the larger true spiders and others which begin as threshold colonists and spread into the deeper parts.

Thus we have:

(1) Beetles.
Staphylinidae.
Cryptophagidae.
Pselaphidae.
Certain groups of *Carabidae*, etc.

(2) Orthoptera.
Crickets.

(3) Apterogota.
Campodea.

(4) Arachnida.
True spiders.
Opilionids.
Mites.

II. Water Animals.

As in the case of land animals, those water animals which are preadapted to some extent to cave life are potential troglophils. These will be those which are nocturnal in habit, or which live in holes, under stones or in mud.

Water troglophils have a tendency to shun the light. Unlike many land troglophils which, if the humidity is sufficient, may stray outside, fully adapted water-troglophils find light an effective barrier, and will remain in the dark parts of the cave, even though there is a free and easy passage out into the light.

Water animals may be:

1. Fish.
2. Crustaceans.
3. Worms.

The only cave in India containing permanent water which I have entered was in the Kaimur Hills of Bihar. There I found a colony of catfish in an isolated pool beyond the reach of any possible flood water about 200 yards from the entrance of the cave.

5. It is evident from the preceding section that most potential troglophils are already adapted wholly or in part to cave life.

There is a marked uniformity of environment in a cave; in consequence accelerated evolution due to climatic vicissitudes, etc. is absent. The population, however, may be small and isolated, and in such a case chance variations even though not adaptive may be fixed. In this way different sub-species or closely related species may come into existence after a relatively short time. If the changes are adaptive, selection will assist the evolution.

6. Adaptations are those changes advantageous to life in caves.

A 'living' cave is one where stalactites and stalagmites are in active formation. Every stalactite has a drop of water hanging on its end, occasionally falling and quickly replaced by a new drop. A film of water covers walls and floor forming occasional pools. The percentage humidity is over 90. The air is clean and fresh, but without noticeable draughts, and the temperature does not vary more than a degree centigrade throughout the year.

A cave in this condition is ideal for troglophils.

Though the air is apparently still it circulates freely and remains good. In places even a mile or more from the entrance there may be a strong draught, sufficient to blow out a candle, but troglophils avoid such places because of the increased evaporation and seek out the parts where the conditions are more equable. They also tend to avoid the main streamways.

The special conditions are:

i. complete darkness.
ii. uniform temperature.
iii. uniformly high humidity.

Proved adaptations are increase in size of sensory organs, e.g.,

i. Increase in length of special setae.
ii. ,, ,, ,, ,, antennae, palps, etc.
iii. ,, ,, ,, ,, legs where they are used for tactile purposes.

Other changes are:

i. loss of colour and pattern.
ii. degeneration, reduction or elimination of eyes.
iii. marked intolerance of reduced humidity.

These are usually considered to be adaptations, but their only advantage is in economy of metabolism. This may be important where food is scanty. Evidence in favour of this provided by those creatures which live on the droppings in bat-infested caves. Here darkness may be complete, but the food is unlimited. Change of colour, degeneration of eyes, etc., does not take place[1].

The loss of colour may be very marked. The legs of some spiders are as transparent as glass and so are the long cerci of the large cave *Campodea*.

Fish speedily become white when introduced into a cave but quickly regain colour when returned to the open.

If the functionless eyes of some cave spiders are the result of disuse, this is an acquired characteristic and should not be heritable. Possibly the newly hatched spiders do have eyes which can be used, and would continue to use them if brought up in the light under suitable conditions. This would be an interesting line of enquiry.

The reduction or complete elimination of eyes, however, is a

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[1] *Encyclopedia entomologique*, VII, Faune cavernicole de la France, 1926, p. 63 by Dr. R. Jeannel.

fundamental change. Here we may have the result of the perpetuation in an isolated community of a chance variation which would be disadvantageous on the surface, but in a cave may be an advantage because economical, and so it would be favoured by selection.

7. A cave is a natural laboratory where some of the variable factors in the outer world are under control.

Some creatures live on in them though they are no longer to be found outside. Indeed it seems to be a significant fact that at the limits of the region of dispersion of a group of animals the living forms are often only to be found in caves.

Careful collection and recording will in course of time shed much light on the course of evolution and on the places of origin of genera and their channels of distribution.

Ancient artificial caves, whether rock dwellings, temples or ancient mines, if of sufficient extent and humidity, and of known date may provide information of great value if their troglophil population is statistically examined in comparison with the same forms on the surface in the locality.

THE ORNITHOLOGICAL DIARY OF A VOYAGE OF S. S. *SAMLUZON*

ST. JOHN N.B. TO KARACHI, INDIA

4 June, 1945 to 7 July, 1945

BY

MAJOR W. W. A. PHILLIPS, F.L.S., M.B.O.U.

Introduction

The observations contained in the following diary were made during a voyage of approximately five weeks duration, across the North Atlantic from St. John N.B. to Cape St. Vincent, then through the Mediterranean and Red Seas and up that part of the Indian Ocean known as the Arabian Sea from Aden to Karachi.

With the exception that we could not change her course, the *Samluzon* our ship, was practically our own. By the kindness of her Master, Captain Howe, and his Officers, we were permitted to go where we wished, at any time of the day or night, consequently we were able to spend many interesting hours on the bridge, in the bows or gazing over the stern, watching the many oceanic birds that crossed our path or crowded into our wake.

Conditions for the observance of bird-life were as good as they could be from ship-board, but even so, it must be remembered